

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁶ : F16L 9/12, 11/08</p>	<p>A1</p>	<p>(11) International Publication Number: WO 99/66246 (43) International Publication Date: 23 December 1999 (23.12.99)</p>
<p>(21) International Application Number: PCT/DK99/00329 (22) International Filing Date: 16 June 1999 (16.06.99) (30) Priority Data: PA 1998 00798 16 June 1998 (16.06.98) DK (71) Applicant (for all designated States except US): NKT CABLES A/S [DK/DK]; Priorparken 510, DK-2605 Brøndby (DK). (72) Inventors; and (75) Inventors/Applicants (for US only): RYTTER, Jan, Christian [DK/DK]; Schlepperejllsgade 62, 3.th., DK-9000 Aalborg (DK). NYGAARD, Jens, Vinge [DK/DK]; Søndre Ringgade 14, 3.th., DK-8000 Aarhus C (DK). (74) Agent: HOFMAN-BANG & BOUTARD, LEHMANN & REE A/S; Hans Bekkevolds Alle 7, DK-2900 Hellerup (DK).</p>		<p>(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments. In English translation (filed in Danish).</p>
<p>(54) Title: A REINFORCED, FLEXIBLE CONDUIT AND A METHOD OF MANUFACTURING SAME</p>		
<p>(57) Abstract</p> <p>A reinforced, flexible pipeline and a method of manufacturing same, said pipeline comprising an inner lining which forms a barrier against flow of the medium flowing through the pipe out to the armouring layers arranged around the inner lining, said inner lining being surrounded by a compression reinforcement which comprises a plurality of profiles wound helically around the inner lining, and a tension reinforcement arranged externally on the compression reinforcement and comprising a plurality of elongated tensile strength imparting elements which extend substantially along the longitudinal direction of the pipe, said elongated tensile strength imparting elements being embedded in a matrix consisting of a solid material different from the elongated tensile strength imparting elements.</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

A reinforced, flexible conduit and a method of manufacturing same

The present invention relates to a reinforced, flexible
5 pipeline and a method of manufacturing such a pipeline
comprising an inner lining forming a barrier against flow
of the medium flowing through the pipeline out to the ar-
mouring layers arranged around the inner lining, said in-
ner lining being surrounded by a compression reinforce-
10 ment which comprises a plurality of profiles wound heli-
cally around the inner lining, a tension reinforcement
being arranged externally on the compression reinforce-
ment and comprising a plurality of elongated tensile
strength imparting elements which twist substantially
15 along the longitudinal direction of the pipeline so as to
allow bending of the pipeline without this creating con-
siderable bending resistance.

Such pipelines are frequently used for conveying liquids
20 and gases at various depths of water, and they are par-
ticularly used in situations where very great or varying
water pressures prevail. Examples of fields of use thus
include riser pipes which extend from the sea bed up to
an installation near the surface of the sea, and between
25 two or more installations which are positioned on the sea
bed at a great depth.

The pipelines are frequently constructed such that an
outer pipeline layer is arranged around the reinforce-
30 ment, consisting of a material which serves to prevent
migration of liquids from the surroundings of the pipe
into the compression reinforcement as well as the tension
reinforcement, as this may cause collapse of the inner
lining or corrosion of the reinforcement. If the pipe is
35 constructed with an inner carcass, the purpose of this is
primarily to protect against such a collapse.

GB 2002084 A discloses a flexible pipeline which has a combined tension and compression relief, externally on which an outer jacket surrounded by metal strips is arranged.

An inner lining and a carcass are provided inwardly of the combined tension and compression relief, but no separate compression reinforcement.

10

Accordingly, the object of the present invention is to provide a pipeline which, to a higher degree than the known ones, prevents liquids from flowing from the surroundings and into particularly the above-mentioned armouring layers.

15

This is achieved according to the present invention by providing a pipeline as mentioned in the opening paragraph, said pipeline being unique in that the elongated tensile strength imparting elements are embedded in a matrix consisting of a solid material different from the elongated tensile strength imparting elements.

20

The matrix of the solid material may thus form a barrier against the above-mentioned migration of liquids into the layers of the pipeline which are present between the tension reinforcement and the inner lining. This barrier is thereby protected by means of the embedded elongated tensile strength imparting elements against being destroyed by e.g. laying and drift of the pipeline, as the elongated tensile strength imparting elements counteract a through-going perforation of the barrier.

30

It should moreover be noted that the tensile strength imparting elements are protected by the embedded matrix against mechanical point loads, and that the outer

35

jacket, which is now not present as an independent jacket, is integrated with and reinforced by the armouring wires.

- 5 On the other hand, the structure of the elongated tensile strength imparting elements does not serve to absorb compression loads, as an independent compression reinforcement is present inwardly of the tensile strength imparting elements according to the invention.

10

A particularly flexible pipeline is achieved if at least one or more of the elongated tensile strength imparting elements forming part of the tension reinforcement are formed by a material having a modulus of elasticity which
15 is higher than the modulus of elasticity of the different solid material forming the matrix which embeds these.

The tensile strength imparting elements may be bound chemically or mechanically to the surrounding matrix,
20 but, alternatively, they may be freely embedded in the matrix.

The flexibility of the pipeline is increased additionally if at least some of the elongated tensile strength imparting elements are twisted around the longitudinal axis
25 of the pipeline.

In a preferred embodiment, the elongated flexible elements are twisted around the longitudinal axis of the pipeline at an angle relative to the longitudinal axis of
30 the pipe which is smaller than the corresponding angle at which the profiles forming the compression reinforcement are wound helically around the longitudinal axis of the pipeline.

35

It is particularly advantageous if the material different from the tensile strength imparting elements is formed by a plastics material, such as e.g. an elastomer. The matrix may hereby be formed in a simple extrusion process.

5

The elongated tensile strength imparting elements may be made of many different materials which each have advantageous properties. Thus, there is a free choice between inter alia metal profiles or profiles which are formed by
10 a composite of metal and ceramics. Alternatively, the elongated tensile strength imparting elements may be formed by a plurality of fibres which are embedded in a plastics material, or by a bundle of fibres which are held together completely or partly to form a pultruded
15 material or a rope.

It is moreover possible to obtain a great protection against penetration of the outer barrier of the pipe, if the elongated tensile strength imparting elements form at
20 least two substantially concentric layers around the longitudinal axis of the pipeline.

In addition, very good properties may be achieved with respect to balancing of torsional forces in the pipe, if
25 the elongated tensile strength imparting elements in each of the substantially concentric layers are twisted around the pipeline at different angles relative to the longitudinal axis of the pipeline, or they twist in an opposite direction around the longitudinal axis of the pipeline so
30 that the elongated tensile strength imparting elements in a first one of the substantially concentric layers intersect the corresponding elongated tensile strength imparting elements in a second one of the substantially concentric layers.

35

The individual layers of the tensile strength imparting elements forming the tension reinforcement may be twisted around the pipeline at different angles, thereby balancing possible torsional forces that are created in the individual layers by a longitudinal pull in the pipeline.

In this connection it is particularly advantageous if the elongated tensile strength imparting elements in a first one of the substantially concentric layers are embedded in such a manner in the surrounding matrix that they do not touch the corresponding elongated tensile strength imparting elements in a second one of the substantially concentric layers. This ensures that the elongated tensile strength imparting elements do not destroy each other upon loading of the pipe, so that the material used for the elongated tensile strength imparting elements may be materials such as carbon fibre, aramid fibre, UHMPE fibre or the like, which have a very high modulus of elasticity and strength in the tensile direction, but a very poor impact resistance.

Further, internally on the inner lining, the pipeline may advantageously be provided with a carcass consisting of one or more helically wound profiles nested or hooked together, thereby providing an additional safeguard against collapse of the inner lining if the pressure on the inner side of the lining drops below the pressure on the outer side of it.

In addition, the reinforced, flexible pipeline may be constructed such that the profiles forming the compression reinforcement in the pipeline are surrounded completely or partly by a free volume which allows flow of liquids or liquid gases along the pipe.

In a particularly advantageous embodiment of the reinforced, flexible pipeline, the elongated tensile strength imparting elements in a first one of the substantially concentric layers are constructed such that they have a substantially plane face which faces toward the corresponding elongated tensile strength imparting elements in an adjacent second layer. This counteracts high tension concentrations in the matrix, and the durability of the matrix is therefore ensured to a maximum degree so that the advantageous properties of the pipeline are maintained for a long time.

This effect may e.g. be improved if the elongated tensile strength imparting elements are formed with a substantially quadrangular cross-section and with corners which have a radius of curvature which is greater than 7% of the smallest dimension of the quadrangular cross-section. Curvature avoids notch effects in the matrix material near the corners of the quadrangular cross-section of the tensile strength imparting elements, so that the durability of the matrix is increased additionally.

As mentioned above, the present invention also relates to a method of manufacturing a reinforced, flexible pipeline comprising an inner lining for forming a barrier against a medium flowing in the pipe, said inner lining being surrounded by a compression reinforcement which comprises a plurality of profiles wound around the inner lining, a tension reinforcement being arranged externally on the compression reinforcement and comprising a plurality of elongated tensile strength imparting elements which extend substantially along the longitudinal direction of the pipe. The invention provides an extremely simple way of producing such a pipeline, by means of which a relatively low weight of the produced pipe may be obtained, while allowing the use of composite materials in the

structure of the pipe. This is achieved in that the inner lining and the associated compression reinforcement, together with the elongated tensile strength imparting elements, are advanced through an extruder which extrudes
5 a matrix surrounding each of the elongated tensile strength imparting elements so as to form a pipe around the compression reinforcement, said pipe consisting of the elongated tensile strength imparting elements which are embedded in the extruded matrix. Application of these
10 layers may take place in one or more stages.

This method may be simplified additionally if the elongated tensile strength imparting elements are held at a predetermined mutual distance until they are embedded in
15 the extruded matrix.

The invention will be described more fully below with reference to the drawing, in which:

20 Fig. 1 is a basic view illustrating the structure of a segment of a pipe according to the invention.

Fig. 2 is a corresponding sectional view illustrating an example of the structure of a known pipe.

25 Fig. 2 thus shows a segment of a flexible pipeline of a generally known type which is frequently used as a riser pipe between installations on the sea bed and an installation which is present at the surface of the sea. This
30 may e.g. be in connection with oil or gas recovery or transport. The pipeline may also be used as a transport pipeline between two installations both of which are present on the sea bed or relatively deep below the surface of the sea. As a third possibility, the pipe may be
35 used between two installations at the surface of the sea, such as two ships.

In at least some of the above-mentioned fields of use it is clear that the pipeline may be affected by very great pressures from the surroundings in particular, which makes very great demands on the structure of the pipe which must be capable of withstanding these pressures. This makes it expedient to have a layered pipe structure in which the individual layers have different functions. As shown in fig. 2, this layered structure consists of an inner layer in the form of a carcass 1, which is formed by one or more metal strips 2 which are wound helically so as to form an inner pipe, said metal strip 2, during the winding, being formed with flaps which engage each other so as to lock the individual turns in the helically wound strip 2 to each other in such a manner that the carcass 1 can still bend after the winding.

A lining 3 of a suitable plastics material is then provided externally on the carcass 1 in a generally known extrusion process, said lining forming a suitable barrier ensuring that the medium flowing in the pipeline does not penetrate into the intermediate layers of the pipeline.

One or more metal profiles 5, 6, which form turns having a very small pitch relative to the longitudinal direction of the pipeline, are then wound helically externally on the lining 3 in a conventional manner. From a conventional point of view, these turns thus offer a great resistance to bursting of the lining 3 and the carcass 1 because of a high pressure on the inner side of the pipeline, the reinforcement formed by these profiles being frequently called a compression reinforcement 4. As will be seen, the profiles 5, 6, which constitute the compression reinforcement 4, are formed by C-, T- or other profiles, the profiles 5, 6 being so oriented in the pipe-

line that two layers of turns wound around the lining 3 in the same direction engage each other.

5 In the known pipelines, a further reinforcement is arranged externally on the compression reinforcement 4, said further reinforcement consisting of one or more layers of profiles 7, 8 which are frequently helically wound with a considerably greater pitch than the profiles 5, 6 which form the above-mentioned compression reinforcement 4, so that they can effectively absorb the
10 great tensile forces which are created in the pipeline in use. This outer reinforcement is therefore frequently called the tension reinforcement.

15 The individual layers of profiles 7, 8 in the tension reinforcement may expediently be wound in mutually different directions around the longitudinal axis of the pipeline, as shown in fig. 2, whereby they moreover create an effective balancing of torsional moments in the pipe during tensile impacts on it.
20

Furthermore, the above-mentioned layers of profiles may have interposed between them relatively thin layers of a material which inter alia serve to prevent tearing between adjacent profiles when the pipes are bent, but may
25 also have other use-specific purposes.

Externally on the tension reinforcement, which comprises the above-mentioned helically wound profiles 7, 8, the
30 known pipelines have an outer jacket 9 which may be constructed very differently, but which at least comprises a layer preferably of plastics, whose purpose is inter alia to serve as a barrier against flow of fluids inwards between the profiles 5, 6, 7, 8 from the surroundings.

Clearly, there are known pipelines having other structures than the one shown in fig. 2. Thus, e.g., there are pipelines in which the inner carcass 1 is omitted so that the lining 3 forms the innermost layer of the pipeline.

5 However, the carcass is frequently used in connection with pipelines which are affected by great outer pressures, as a possible increase in the pressure between the outer jacket 9 and the lining 3 because of a possible leakage on the pipeline to the external environment may

10 cause collapse of the lining 3, which is counteracted by the carcass 1.

Now, fig. 1 shows a pipeline according to the present invention which contains all the layers shown in fig. 2,

15 except the outer jacket 9 and the tension reinforcement consisting of the profiles 7, 8 according to fig. 1.

As regards the carcass 11, the lining 13 and the compression reinforcement 14, the structure thus corresponds in

20 principle to the corresponding parts of the pipeline shown in fig. 2.

According to the invention, however, the tension reinforcement consisting of the profiles 7, 8 and the outer

25 jacket 9 shown in fig. 2, is replaced by a hydrostatically tight tension reinforcement 10 comprising a plurality of profiles 15, 16, which are embedded in a matrix 17 of a material having a modulus of elasticity which is smaller than the modulus of elasticity of the profiles

30 15, 16. The tension reinforcement 10 hereby forms an outer jacket which both constitutes a barrier against ingress of fluids from the surroundings to the underlying layers of the pipe, but which moreover gives the pipeline the necessary resistance to tensile forces during laying

35 and particularly use of the pipeline.

Since the tension reinforcement 10 according to the invention is thus an integrated unit which forms a substantially hydrostatically tight pipe around the vital inner layers of the pipeline, and since this hydrostatically tight pipe contains reinforced profiles 15, 16, it is clear that the risk of the hydrostatically tight pipe being perforated in use is extremely low, as the profiles 15, 16 prevent this.

10 This makes it possible completely to omit or at least to dimension particularly the carcass 1 smaller than is common in the known pipelines, without this involving an increased risk of collapse of the pipeline by unintended influx of fluids from the surroundings of the pipe and
15 the consequently increased pressure on the outer sides of the carcass 1 and of the lining 3.

Since, additionally, the shown structure involves an embodiment in which the profiles 15, 16 do not touch each other directly, it is clear that this allows more liberty
20 in the selection of materials for forming the profiles 15, 16. Thus, it is possible to select materials which have a lower impact resistance than e.g. various steel and aluminium materials, but which have a considerably
25 higher specific strength in the tensile direction, without this having a significant importance for the risk of mechanical damage on the profiles particularly in the areas in which they intersect each other.

30 As will be seen in the figure, the profiles 15, 16 in the tension reinforcement 10 are wound around the longitudinal axis of the pipeline with a very high pitch, and since they are wound in mutually opposite directions around the longitudinal axis of the pipeline, great balancing of torsional forces, which may occur in the pipe-
35 line in particular in use, is achieved.

Clearly, the skilled person will be able to devise a number of other embodiments of pipelines which basically involve the same advantages and basic principles as the one shown in fig. 1. Thus, more layers may be arranged in the pipes depending on the specific use. These additional layers may both be arranged below the above-mentioned tension reinforcement 10 and externally on it. Further, many different materials may be used both for the profiles forming part of the pipeline, and for the plastics layers which are incorporated.

Clearly, the stated matrix may be arranged such that it is chemically or mechanically anchored to the tension reinforcement, but it may also be loose in it.

In the preferred embodiments of the invention, the carcass and the profiles 18, 19, which form the compression reinforcement 14, are made of a metal, such as steel, stainless steel, titanium or aluminium. As regards the tension reinforcement 10, this is advantageously formed by profiles 15, 16 which are made of steel or a titanium alloy, or a material consisting of fibres of glass, carbon, aramid or another material containing the desired properties which is embedded in a matrix of a polymeric material, and the matrix material 17 surrounding the profiles 15, 16 may advantageously be formed by a thermoplastic elastomer or a vulcanizable polymeric material.

The profiles 15, 16 forming part of the tension reinforcement 10 may advantageously be formed with at least one plane side which is wider than 20% of the maximum cross-sectional width of the profile 15, 16, and more expediently the profiles 15, 16 may be formed as quadrangular profiles having at least two parallel sides, with the corners formed with a radius of curvature which is

greater than 7% of the smallest cross-sectional width of the quadrangular cross-section. As a result, the risk that the matrix 17 surrounding the profiles 15, 16 is destroyed by bending of the pipeline is minimized, since a
5 relatively large uniformly thick face of the matrix material is obtained between the closest areas on two profiles which intersect each other, so that no great tension concentrations are created in the material, and there is no risk of notch effects in the matrix material
10 because of the rounded corners.

P a t e n t C l a i m s :

1. A reinforced, flexible pipeline comprising an inner
5 lining which forms a barrier against flow of the medium
flowing through the pipe out to the armouring layers ar-
ranged around the inner lining, said inner lining being
surrounded by a compression reinforcement which comprises
a plurality of profiles wound helically around the inner
10 lining, a tension reinforcement being arranged externally
on the compression reinforcement and comprising a plural-
ity of elongated tensile strength imparting elements
which extend substantially along the longitudinal direc-
tion of the pipe, c h a r a c t e r i z e d in that the
15 elongated tensile strength imparting elements are embed-
ded in a matrix consisting of a solid material different
from the elongated tensile strength imparting elements.

2. A reinforced, flexible pipeline according to claim 1,
20 c h a r a c t e r i z e d in that at least one or more
of the elongated tensile strength imparting elements
forming part of the tension reinforcement are formed by a
material having a modulus of elasticity which is higher
than the modulus of elasticity of the surrounding solid
25 material forming the matrix which embeds these.

3. A reinforced, flexible pipeline according to claim 1
or 2, c h a r a c t e r i z e d in that at least some of
the elongated tensile strength imparting elements are
30 twisted around the longitudinal axis of the pipeline.

4. A reinforced, flexible pipeline according to claim 3,
c h a r a c t e r i z e d in that the elongated flexible
elements which are twisted around the longitudinal axis
35 of the pipeline, are twisted at an angle relative to the
longitudinal axis of the pipe which is smaller than the

corresponding angle at which the profiles forming the compression reinforcement are wound helically around the longitudinal axis of the pipeline.

5 5. A reinforced, flexible pipeline according to one of the preceding claims, c h a r a c t e r i z e d in that the material different from the tensile strength imparting elements is formed by a thermoplast, a rubber or a thermoplastic elastomer and mixtures in which these are
10 contained.

6. A reinforced, flexible pipeline according to one of the preceding claims, c h a r a c t e r i z e d in that at least some of the elongated tensile strength imparting
15 elements are formed by metal profiles, or by profiles which are formed by a composite of metal and ceramics.

7. A reinforced, flexible pipeline according to one of the preceding claims, c h a r a c t e r i z e d in that
20 at least some of the elongated tensile strength imparting elements are formed by a plurality of fibres which are embedded in a plastics material.

8. A reinforced, flexible pipeline according to one of
25 the preceding claims, c h a r a c t e r i z e d in that at least some of the elongated tensile strength imparting elements are each formed by a bundle of fibres which are held together completely or partly to form a pultruded material or a rope.

30 9. A reinforced, flexible pipeline according to one of the preceding claims, c h a r a c t e r i z e d in that the elongated tensile strength imparting elements form at least two substantially concentric layers around the longitudinal axis of the pipeline.
35

10. A reinforced, flexible pipeline according to claim 9, c h a r a c t e r i z e d in that the elongated tensile strength imparting elements in each of the substantially concentric layers are twisted around the pipeline at different angles relative to the longitudinal axis of the pipeline, or in that they twist in an opposite direction around the longitudinal axis of the pipeline, so that the elongated tensile strength imparting elements in a first one of the substantially concentric layers intersect the corresponding elongated tensile strength imparting elements in a second one of the substantially concentric layers.

11. A reinforced, flexible pipeline according to claim 9 or 10, c h a r a c t e r i z e d in that the elongated tensile strength imparting elements in a first one of the substantially concentric layers are embedded in such a manner in the surrounding matrix that they do not touch the corresponding elongated tensile strength imparting elements in a second one of the substantially concentric layers.

12. A reinforced, flexible pipeline according to one of the preceding claims, c h a r a c t e r i z e d in that internally on the inner lining the pipeline is provided with a carcass consisting of one or more helically wound and nested or interconnected profiles.

13. A reinforced, flexible pipeline according to one of the preceding claims, c h a r a c t e r i z e d in that the profiles forming the compression reinforcement in the pipeline are surrounded completely or partly by a free volume which allows flow of liquids or liquid gases in the longitudinal direction of the pipe.

14. A reinforced, flexible pipeline according to one of claims 9 to 11, c h a r a c t e r i z e d in that the elongated tensile strength imparting elements in a first one of the substantially concentric layers are formed
5 such that they have a substantially plane face which faces toward the corresponding elongated tensile strength imparting elements in an adjacent second layer.

15. A reinforced, flexible pipeline according to claim
10 14, c h a r a c t e r i z e d in that the elongated tensile strength imparting elements are formed with a substantially quadrangular cross-section and with corners having a radius of curvature which is greater than 7% of the smallest dimension of the quadrangular cross-section.

15
16. A method of manufacturing a reinforced, flexible pipeline comprising an inner lining for forming a barrier against a medium flowing in the pipe, said inner lining being surrounded by a compression reinforcement which
20 comprises a plurality of profiles wound around the inner lining, a tension reinforcement being arranged externally on the compression reinforcement and comprising a plurality of elongated tensile strength imparting elements which extend substantially along the longitudinal direc-
25 tion of the pipe, c h a r a c t e r i z e d in that the inner lining and the associated compression reinforcement, together with the elongated tensile strength imparting elements, are advanced through an extruder which extrudes a matrix surrounding each of the elongated ten-
30 sile strength imparting elements so as to form a pipe around the compression reinforcement, said pipe consisting of the elongated tensile strength imparting elements which are embedded in the extruded matrix.

35 17. A method according to claim 16, c h a r a c t e r - i z e d in that it is performed in two or more stages.

18. A method according to claim 16 or 17, c h a r a c -
t e r i z e d in that the elongated tensile strength im-
parting elements are held at a predetermined mutual dis-
5 tance until they are embedded in the extruded matrix.

1/2

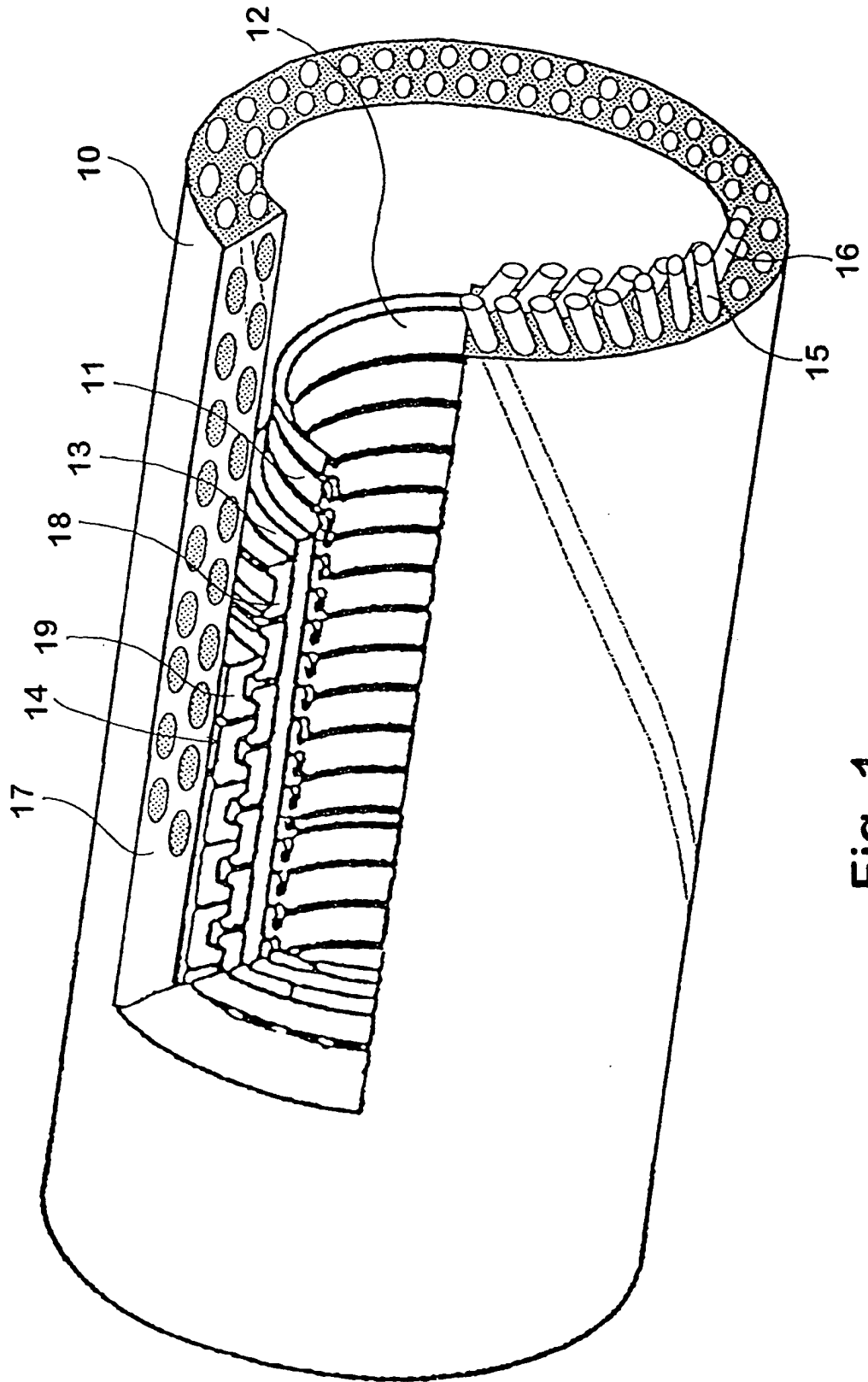


Fig. 1

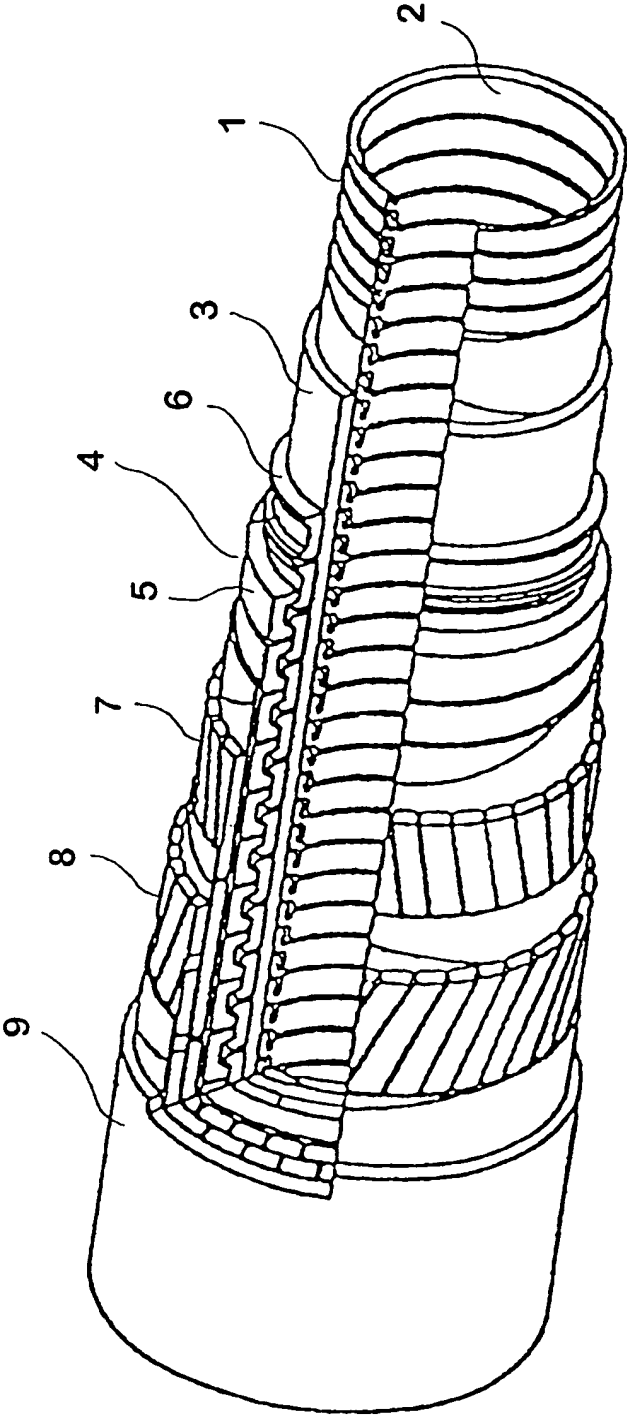


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 99/00329

A. CLASSIFICATION OF SUBJECT MATTER		
IPC6: F16L 9/12, F16L 11/08 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC6: F16L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 2105120 A (BATTELLE-INSTITUT E.V.), 10 August 1972 (10.08.72), page 7, line 15, figures 1-2	1,3,4-6, 9-11,14,15
Y	--	16-18
Y	US 3477474 A (L.L. MESLER), 11 November 1969 (11.11.69), column 2, line 57 - line 68, figures 1-3	16-18
A	US 3334663 A (T.F. PETERSON), 8 August 1967 (08.08.67)	--
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
8 Sept 1999		12 -10- 1999
Name and mailing address of the ISA: Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer Axel Lindhult Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 99/00329

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3506040 A (W.O. EVERLING ET AL), 14 April 1970 (14.04.70) -- -----	

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/08/99

International application No.
PCT/DK 99/00329

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
DE	2105120	A	10/08/72	NONE	

US	3477474	A	11/11/69	DE 1625508 A	09/03/72
				ES 347767 A	01/03/69
				FR 1553198 A	10/01/69
				GB 1201804 A	12/08/70

US	3334663	A	08/08/67	NONE	

JS	3506040	A	14/04/70	NONE	
